



Robert L. Ehrlich, Jr., Governor

Michael S. Steele, Lt. Governor

C. Ronald Franks, Secretary

Maryland Licensed Tree Expert Exam Study Guide

For Exam Domain:

Tree Support Systems and Lightning Protection

Version 2.0

Date: 11/05

Prior to installation of any support system, objectives shall be clearly defined (i.e., provide supplemental support to a codominant limbs; provide supplemental support to overextended branch; etc.). Once a cabling system is properly installed, it needs to be periodically inspected. Prior to installation, the owner of the tree or other responsible party should be notified that such inspections will be needed, and that they shall be the responsibility of the tree owner. Items requiring inspection include the system condition, position and cable tension, as well as the tree's structural integrity. As the tree will grow and change over time, the system may need to be replaced, relocated or maintained in order to stay functional. Trees that will be cabled or braced should normally also be pruned (reduced, cleaned and/or thinned) in order to reduce weight at the ends of long branches.

When drilling holes for hardware installation, the hole for lag-thread (wood screw type threads) hardware shall be slightly smaller (1/16 inch to 1/8 inch) than the diameter of the lag as you want the threads to bite into the wood for attachment. When using threaded steel rods or eye bolts (machine screw type threads), the drill hole should be slightly larger (no more than 1/8 inch) than the hardware as this type of hardware should pass through the hole unobstructed and be attached by nuts and washers at the ends. If existing cables are to be replaced, they shall not be removed until the new system is installed. They may be holding parts of the tree together and whole or partial tree failure could result if the existing support is removed before the new one is installed.

A system is only as strong as the weakest component. Cabling systems should be designed so that system components (anchors, cables, etc.) have compatible working loads (see ANSI A300 (Part 3)-2000 Annex A; ISA Best Management Practices-Tree Support Systems: Cabling, Bracing, and Guying, Table 4). Through-braces shall be used when bracing through decayed wood or in trees that are poor compartmentalizers or have weak wood. Anchors and braces shall not be installed in decayed areas where sound wood is less than 30% of the trunk or branch diameter. Lag hooks are also not considered safe in soft wood and decayed wood and should not be used on any limb larger than 10 inches.

Longitudinal alignment of anchors and/ or braces should be avoided. This means that if you have multiple pieces of hardware attached to the same trunk or branch, one should be higher than the other by



a distance greater than or equal to the diameter of the trunk or branch, and that the pieces of hardware should be offset so that one is not directly above the other.

The proper ratio of cables to anchors is 1:1. Do not attach more than one cable to an anchor. Anchors for cables should be installed at approximately 2/3rds of the length of the limb to be supported (starting at the crotch or trunk, go 2/3rds of the distance to the branch tip). The cables and hardware shall be installed in alignment with each other because as the angle pull varies from 0 degrees (the cable moves away from a direct alignment with the hardware), the strength of the anchor decreases. Using an eye bolt several inches longer than the diameter of the branch allows room for adjusting the tension of the cable. A turnbuckle (a drop-forged, closed-eye device) can also be used for adjusting tension. These are important as the cables should be taut following installation. Dead-end grip terminations shall use thimbles. A thimble is the device used to protect the cable as it passes through the eye-splice. When installing support system hardware, washers shall not be countersunk into the wood.

There are four primary types of cabling systems. A cable system involving a single cable between two branches of approximately equal size is referred to as direct cabling. When maximum support is required, the preferred system of cabling is triangular, which consists of connecting three tree parts in combination of threes. Box cabling connects four or more tree parts in a closed system, and should only be used when minimal support is needed. Hub and Spoke cabling systems (all cables are connected to a central hub rather than to other trunks or branches) should only be used when other installation techniques cannot be installed.

Bracing is normally used in conjunction with, rather than instead of, cabling. A large split or weak crotch normally requires two or more rod(s) to hold the two sections together and minimize twisting. For large, weak, or split crotches, one bracing rod should be inserted through the crotch and one more above it, separated by a vertical distance equal to or greater than the diameter of the tree at the rod.

When tree-to-tree guying, anchor trees shall: be inspected for structural integrity; have the ability to meet the objective; and, be attached in their lower half to the upper half of the support tree. Ground-anchor(s) should be placed no closer to the trunk than 2/3rds the distance from the ground to the height of the lowest point of attachment in the tree.

Prior to installation of a lightning protection system, the owner or owner's agent should be notified of the need for periodic inspection of the system. Inspections are the responsibility of the tree owner, and should include the system's condition, position, and grounding integrity. The uppermost point of a lightning protection system, intended to intercept lightning strikes, is the air terminal. A tree point, blunt terminal, or the end of the conductor may be used as the air terminal. The conductors shall be at least 14 strands of 17 AWG copper wire. If a tree with a lightning protection system has also been cabled, the cables should be connected to the lightning protection system by a bronze or bimetallic connector clamp. Branch conductors should be installed so that no aerial portion of the tree is farther than 35 feet from a conductor. When installing lightning protection systems, conductors shall be fastened to the trees with drive fasteners, installed at intervals of no more than 6 feet.

Ground terminal installation should not damage roots greater than 2 inches in diameter. When using a single ground rod system, the ground rod shall be installed in the soil, at least 10 feet from the trunk. A multiple ground system, using multiple rods, should be used when the full length of a single rod

cannot be driven into the soil. When using a multiple ground system, a minimum of 8 feet of total ground rod length shall be installed. Horizontal ground systems should be preferred when ground rods cannot be driven at least 2 feet into the soil. Conductors shall extend away from the tree at a minimum depth of 8 inches, except when impenetrable conditions do not allow.